

NEW EQUIPMENT FOR MINE SAFETY

Advanced machinery for underground coal mining highlights technology transfers in the field of public safety

Anthropometry is the study of the size, shape and motion characteristics of the human body. It is fundamental to successful design of clothing, equipment and workplaces in flight vehicles, and both NASA and the military services have long been engaged in research to improve the interface between man and the airplane cockpit. The advent of manned spacecraft complicated the design job by introducing such new influences as weightlessness and the need for more complex protective equipment.

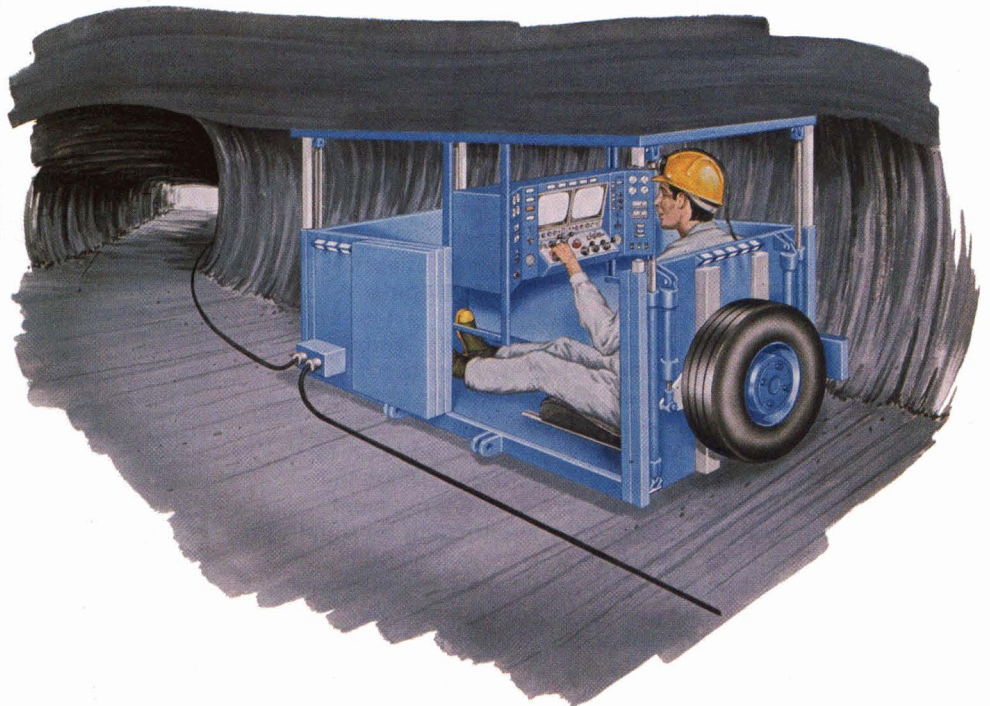
In planning for the Space Shuttle, NASA encountered a number of additional considerations: the spacecraft would be the largest ever built and would carry more people than prior spacecraft; missions would involve more motion within and without the spacecraft, including transfers from pressurized to non-pressurized areas; the types of work to be performed would differ from earlier manned space

operations; and crew members would include persons of both sexes, many of them non-pilots and most of a different age bracket than earlier astronauts. These and other factors affected design criteria for astronaut clothing, equipment, workspace layouts, habitability areas and life support hardware in both the Shuttle Orbiter and the Spacelab module.

Johnson Space Center (JSC) felt that these multiple design considerations demanded a larger anthropometric data base. Accordingly, JSC undertook to assemble the information available worldwide and to produce a centralized collection of anthropometric knowledge. It was intended for use not only by NASA, the military and aerospace contractors, but for such non-aerospace designers of clothing, equipment and workplaces as engineers, architects and the garment industry. JSC contracted with Webb Associates, Yellow



Above, engineers of The Bendix Corporation are working on the design of a system that would permit an operator to remain outside a danger zone while controlling his coal mining machine remotely. The artist's concept at right shows the operator's cab, connected by cable to the cutting machine, which is working out of sight under an unsupported roof. The two TV screens in the cab show the machine in operation and allow the operator to guide its movement.





In low seam coal mining operations, machines called continuous miners and their operators' cabs must negotiate passageways frequently less than four feet high. This multiple exposure shows how the seat, canopy and control column of the Bendix cab can be adjusted to changing tunnel heights.

standing work stations under the unsupported roof. With the Bendix system, the operator would sit in a cab, located under secured roofing and protected from rock fall by a strong metal canopy, while using "hands off" automatic drilling and bolt tightening equipment.

Bendix engineers used the *Anthropometric Source Book* in determining optimal dimensions of the operator cab and in placement of controls. The controls allow the operator to work his machinery more efficiently and to raise or lower his cab seat or cab roof for maximum comfort as the height of the tunnel ceiling changes. Assessment of anthropometric factors was particularly important in determining the operator's proper eye height for best visibility, and in designing an adjustable seat for such a restricted and dynamic workplace. Bendix has built prototypes of both vehicles, which are undergoing evaluation by USBM; if approved by the Bureau, they will be demonstrated to representatives of the mining industry and mining equipment manufacturers.

Springs, Ohio to compile and edit the information.

The result was a three-volume *Anthropometric Source Book*, which is more than its title suggests; it is not only a complete survey of data—much of it previously unpublished—but also an effective guide to the application of anthropometric information. It includes such subjects as the variability of human body sizes, mass distribution properties of the body, arm and leg reach, joint motion, strength, the design of clothing and workplaces, physical changes to the human body in zero gravity, guidelines for statistical analysis of anthropometric data, and tabulated anthropometric information from surveys of 61 different population groups in the United States, Europe and Asia. Widely distributed to potential users, the work drew acclaim as an important addition to knowledge of human factors engineering, a document that may influence workplace and equipment design in many non-aerospace fields. One dramatic example is a U.S. Bureau of Mines (USBM) project in which the source book contributed to design of advanced mining systems developed by USBM's contractor, The Bendix Corporation's Energy, Environment and Technology Office, Englewood, Colorado.

The USBM project, supervised by the Pittsburgh Mining Research Center, seeks safer working conditions for operators of equipment employed in what is known as low seam coal mining, where a low-profile machine called a continuous miner (CM) cuts into coal seams less than four feet high. The CM has a rotating drum on which are mounted carbide-tipped

"spikes" that dig into a wall of coal and reduce it to rubble; the coal is automatically conveyed to a wheeled shuttle vehicle or another conveyor for removal. As the CM bites further and further into the wall, cutting out only the coal and leaving the overhead material, it creates a low tunnel with an unsupported roof.

After advancing about 20 feet into the seam, the CM withdraws to make room for a roof bolting machine, with which an operator drills holes in the overhead strata, inserts large bolts and tightens them to secure the tunnel roof to the solid rock above. Like the roof bolter, the CM and the shuttle vehicle are controlled by human operators. Although some have remote control provisions, these machines generally have small cabs in which the operator is tightly confined, working at times under a ceiling that might be considerably less than 40 inches high. A high risk situation exists for these operators, who frequently incur injuries from striking their heads against very low ceilings while their machines are in motion, or are battered by rock falls.

Bendix has designed a remote cab for the CM and a new roof bolter that would remove the operators from these dangerous situations. The CM would be operated by remote control from a cab located well away from the cutting area under a secured roof. Two television cameras, mounted on the CM and connected to a display screen in the operator's cab, provide a visual link enabling the operator to see the cutting area for guidance of the machine. Roof bolter operators normally drill holes and manually install bolts from



Companion to the continuous miner cab is this cab for the operator of a roof bolting system. Located outside of unsafe areas and protected from rock fall by a strong canopy, the remote operator remains in his cab while using automatic equipment to secure mine roofs to solid rock.